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Distribution of the New England Medicinal Leech, *Macrobdella sestertia* Whitman, 1886 and redeterminations of specimens of *Macrobdella* (Annelida: Clitellata: Macrobdellidae) at the National Museum of Natural History, Smithsonian Institution

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Abstract.—The complete holdings of *Macrobdella* species at the Smithsonian's National Museum of Natural History were examined and the identity of 4 specimen lots were redetermined. One of these lots was redetermined as *Macrobdella sestertia* and represents the first report of this species from New Hampshire. Prior to this report, this species was only known from a few occurrences in eastern Massachusetts and Maine. This is also the first report of this species to be found in sympatry with *Macrobdella decora*, a more common congener with a widespread distribution.

Keywords: copulatory glands, taxonomy, Hirudinea, geographic range, collections

Species of *Macrobdella* Verrill, 1872, also known as North American medicinal leeches, are large hirudineans found in freshwater habitats of North America, including the USA, Canada and Mexico (Klemm 1982). *Macrobdella* is comprised of four species (Sawyer 1986): *Macrobdella decora* (Say, 1824), *Macrobdella sestertia* Whitman, 1886, *Macrobdella ditetra* Moore, 1953, and *Macrobdella diplotertia* Meyer, 1975. *Macrobdella* spp. are easily identified by the olive green dorsum sometimes with reddish-orange spots, and external morphological features of the ventral clitellar region (Klemm 1982; Sawyer 1972, 1986).

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Macrobdella sestertia is one of the rarest hirudiniform leeches in North America. It is considered a poorly known species with few occurrence records and even fewer specimens in scientific collections (Whitman 1886; Sawyer 1972; Smith 1977; Klemm 1982; Smith & Hanlon 1997). It is listed under the State of Massachusetts Endangered Species Act as a Species of Special Concern (SSC) in the Massachusetts State Wildlife Action Plan (Massachusetts Division of Fisheries & Wildlife 2015). This species was only known from coastal areas of eastern Massachusetts and was an elusive species thought possibly to be extinct prior to its rediscovery in 1977 (Smith 1977). It was collected again from Sebec Lake, Maine in 1993 (Smith & Hanlon 1997). The

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geographic distribution of *M. sestertia* has been presumed to be restricted to coastal habitats of New England (Smith 1977; Smith & Hanlon 1997) and in the western extent of its distribution possibly to overlap with that of *M. decora* (Sawyer 1972), but the two species have yet to be found in sympatry.

In 2015, the holdings of *Macrobdella* specimens at the National Museum of Natural History (NMNH), Smithsonian Institution, were assessed and the identifications of four specimen lots were re-determined.

Materials and Methods

RSM and AJP critically examined diagnostic external morphological features of the gonopores and copulatory glands of specimens identified as *Macrobdella* species from the Department of Invertebrate Zoology annelid collection (NMNH, Smithsonian Institution, Washington, D.C.). Specimens were examined with the aid of a Leica® M125 stereomicroscope. Photographs were taken with a Leica® IC80 HD attached to the stereomicroscope and images were adjusted for levels to improve clarity in Adobe® Photoshop® CS6.

Results

A total of 117 specimen lots of *Macrobdella* were examined. A complete list of the holdings of *Macrobdella* specimen lots at the NMNH with specimen information is provided in Table 1. The identification of USNM 38898 (*M. ditetra*) could not be verified because the specimens were shriveled, as well as 3 of the 29 specimens of USNM 38912 (*M. ditetra*) because the specimens were creased on the ventral side in the gonopore region, an artifact of preservation. Of the specimen lots examined, the identity of 4 lots was re-determined as follows.

Genus *Macrobdella* Verrill, 1872

Macrobdella decora (Say, 1824)

Material examined.—One lot identified as *Macrobdella ditetra*: USNM 43544, ex 1, collected from near Great Falls of the Potomac, Virginia, by Paul Bartsch, no collecting date given.

Remarks.—The leech had 4 + ½ annuli between the gonopores and two accessory pores in each of two rows, with the first row of pore openings five annuli posterior to the female gonopore. Based on these features the specimen was re-determined to be *M. decora*.

Macrobdella ditetra Moore, 1953

Material examined.—Two lots identified as *Macrobdella* sp.: USNM 41353, ex 1, collected from Station MCM 642, Chatham, Jackson Parish, Louisiana, by G. H. Penn and G. H. Bick, on 1 April 1952; USNM 41354, ex 1, collected from Station MCM 642, Eureka, Ouachita Parish, Louisiana, by G. H. Penn and G. H. Bick, on 1 April 1950.

Remarks.—These leeches had two annuli between the gonopores and four accessory pores in each of two rows, with the first row of pores opening eight annuli posterior to the female gonopore. Based on these features the specimens were re-determined to be *M. ditetra*.

Macrobdella sestertia Whitman, 1886
Figs. 1–3

Material examined.—One lot identified as *Macrobdella decora*: USNM 50162, ex 4, collected from Suncoop Pond, 2.75–3.25 miles East of Epsom, Rockingham County, New Hampshire, by R.M. Bailey and Oliver, on 3 June 1938.

Remarks.—One leech had four accessory gland pores on the ventral surface posterior to the gonopores with four + ½ annuli between the gonopores, characters diagnostic of *M. decora*. Three leeches

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Table 1.—*Macrobdella* specimens of the NMNH with identifications confirmed or redetermined in this study. USNM catalog numbers marked with a section sign (§) indicate the identification of the specimens as it was redetermined in this study. USNM catalog numbers marked with an asterisk (*) indicates the designation of holotype and caret (^) indicates the designation of paratype. ([a]) indicates the specimen lot is part of the collection of C.O. Whitman.

Catalog number	Scientific name	Specimen count	Collection date	Country of origin	State/province of origin	Precise locality
USNM 209	*Macrobdella decora*	3	–	U.S.A.	Connecticut	New Haven
USNM 1037	*Macrobdella decora*	2	23 September 1883	U.S.A.	Massachusetts	Woods Hole
USNM 4599	*Macrobdella decora*	2	–	U.S.A.	Virginia	Wytheville
USNM 19076	*Macrobdella decora*	1	June 1921	U.S.A.	Maryland	Plummer's Island, near Washington, D.C.
USNM 19128	*Macrobdella decora*	2	2 April 1922	U.S.A.	Maryland	Potomac near Plummer's Island
USNM 20693	*Macrobdella decora*	1	–	Canada	Quebec	No locality label, probably Trois Pistoles
USNM 20694	*Macrobdella ditetra*	1	15 June 1938	U.S.A.	Florida	Osceola National Forest, Lake City
USNM 30210	*Macrobdella ditetra*	4	24 January 1935	U.S.A.	Florida	Near Knight's Station
USNM 30215	*Macrobdella ditetra*	1	–	U.S.A.	Florida	Lake Homey, Lakeland
USNM 30218	*Macrobdella ditetra*	4	4 June 1904	U.S.A.	Texas	O' Connor's Lake, Refugio County
USNM 30224	*Macrobdella ditetra*	8	23 February 1935	U.S.A.	Florida	Near Gainesville
USNM 30226	*Macrobdella decora*	1	10 May 1911	U.S.A.	Maryland	Laurel
USNM 30228	*Macrobdella ditetra*	1	21 August 1957	U.S.A.	Florida	Everglades City
USNM 30235	*Macrobdella ditetra*	1	18 February 1906	U.S.A.	Florida	Turkey Hammock Magnetic Station, U.S. Coast Survey, Kissimmee River
USNM 30248	*Macrobdella ditetra*	2	4 June 1904	U.S.A.	Texas	O' Connor's Lake, Refugio County
USNM 36345*	*Macrobdella ditetra*	1	May 1916	U.S.A.	Louisiana	Marshes near New Orleans
USNM 36346^	*Macrobdella ditetra*	3	1916	U.S.A.	Louisiana	Marshes near New Orleans
USNM 36347^	*Macrobdella ditetra*	14	May 1916	U.S.A.	Louisiana	Near New Orleans
USNM 36400^	*Macrobdella ditetra*	1	1934	U.S.A.	North Carolina	Washington
USNM 38860	*Macrobdella decora*	33	August 1889	U.S.A.	Massachusetts	Woods Hole
USNM 38861[a]	*Macrobdella decora*	15	–	–	–	–
USNM 38862	*Macrobdella decora*	4	30 August 1919	U.S.A.	New York	Carr Pond, Palisades Interstate Park
USNM 38863	*Macrobdella decora*	6	8 July 1919	U.S.A.	New York	Palisades Interstate Park
USNM 38864	*Macrobdella decora*	2	September 1938	U.S.A.	North Carolina	Elon College
USNM 38865	*Macrobdella decora*	16	Summer 1950	U.S.A.	Iowa	Lakes near Marshalltown

Table 1.—Continued.

Catalog number	Scientific name	Specimen count	Collection date	Country of origin	State/province of origin	Precise locality
USNM 38866	*Macrobdella decora*	26	August 1923	U.S.A.	Michigan	Mud Lake, Cheboygan County
USNM 38867	*Macrobdella decora*	2	–	–	–	–
USNM 38868	*Macrobdella decora*	1	12 August 1922	Canada	Ontario	Hill Lake
USNM 38869	*Macrobdella decora*	1	June 1924	Canada	Ontario	Lake Nipigon
USNM 38870	*Macrobdella decora*	1	3 August 1933	Canada	Ontario	Perch Lake
USNM 38871	*Macrobdella decora*	1	15 July 1934	Canada	Ontario	Small Muskeg Lake
USNM 38872	*Macrobdella decora*	1	1933	Canada	Alberta	Fawcett
USNM 38873	*Macrobdella decora*	4	Summer 1932	U.S.A.	Massachusetts	Cape Cod, Sandwich County
USNM 38874	*Macrobdella decora*	1	19 June 1929	U.S.A.	New Hampshire	Grafton Mountains
USNM 38875	*Macrobdella decora*	3	10 June 1934	U.S.A.	Vermont	Belmont
USNM 38876	*Macrobdella decora*	5	Summer 1948	U.S.A.	Maine	Stoneham
USNM 38877	*Macrobdella decora*	3	8 September 1934	U.S.A.	New York	Black Pond
USNM 38878	*Macrobdella decora*	2	September 1937	U.S.A.	New York	Davenport Lake, Cold Spring Harbor, Long Island
USNM 38879	*Macrobdella decora*	4	5 August 1940	U.S.A.	New York	Cold Spring Harbor, Long Island
USNM 38880	*Macrobdella decora*	4	March 1957	U.S.A.	Iowa	–
USNM 38882	*Macrobdella decora*	8	December 1907	U.S.A.	Minnesota	–
USNM 38883	*Macrobdella decora*	2	December 1907	U.S.A.	Minnesota	–
USNM 38884	*Macrobdella decora*	3	December 1907	U.S.A.	Minnesota	–
USNM 38885	*Macrobdella decora*	1	December 1907	U.S.A.	Minnesota	–
USNM 38886	*Macrobdella decora*	1	29 July 1913	U.S.A.	Michigan	Whitefish Point, Chippewa County
USNM 38887	*Macrobdella decora*	1	24 August 1925	U.S.A.	Michigan	Thomas Lake, Obsego County
USNM 38888	*Macrobdella decora*	2	16 August 1925	U.S.A.	Michigan	"S" Lakes, Obsego County
USNM 38889	*Macrobdella decora*	6	1926	U.S.A.	Michigan	Marquette
USNM 38890	*Macrobdella decora*	1	13 August 1937	U.S.A.	Michigan	Chicago Lake, Delta County
USNM 38891	*Macrobdella decora*	2	15 April 1930	Mexico	Nuevo Leon	Arroyo Alamo, near Juarez
USNM 38892	*Macrobdella decora*	1	–	U.S.A.	Wisconsin	Wabekon Lake, Forest County
USNM 38896	*Macrobdella ditetra*	1	18 June 1918	U.S.A.	Louisiana	Walnut Bayou
USNM 38897	*Macrobdella ditetra*	2	–	U.S.A.	South Carolina	Charleston
USNM 38898	*Macrobdella ditetra*	1	19 February 1933	U.S.A.	North Carolina	Washington
USNM 38899	*Macrobdella ditetra*	1	9 July 1934	U.S.A.	North Carolina	Washington
USNM 38900	*Macrobdella ditetra*	1	1934	U.S.A.	North Carolina	Washington
USNM 38901	*Macrobdella ditetra*	1	1934	U.S.A.	North Carolina	Washington

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Table 1.—Continued.

Catalog number	Scientific name	Specimen count	Collection date	Country of origin	State/province of origin	Precise locality
USNM 38902	*Macrobdella ditetra*	1	1 May 1948	U.S.A.	Texas	Hardin County
USNM 38903	*Macrobdella ditetra*	1	16 December 1948	U.S.A.	Louisiana	Iberville Parish
USNM 38904	*Macrobdella ditetra*	1	7 April 1950	U.S.A.	Mississippi	Forrest County
USNM 38905	*Macrobdella ditetra*	1	25 March 1923	U.S.A.	Louisiana	Covington
USNM 38906	*Macrobdella ditetra*	3	Probably 1918	U.S.A.	Louisiana	Mound
USNM 38907	*Macrobdella ditetra*	2	15 April 1914	U.S.A.	Louisiana	Bermudcy Lake, New Orleans
USNM 38908	*Macrobdella ditetra*	1	6 December 1923	U.S.A.	Louisiana	New Orleans
USNM 38909	*Macrobdella ditetra*	5	Summer 1939	U.S.A.	Florida	Lake City
USNM 38910	*Macrobdella ditetra*	1	1 May 1952	U.S.A.	Florida	Peace River, Polk County
USNM 38911	*Macrobdella ditetra*	11	March 1952	U.S.A.	Florida	Alachia County
USNM 38912	*Macrobdella ditetra*	11	April 1923	U.S.A.	Louisiana	New Orleans
USNM 40534	*Macrobdella decora*	1	13 August 1919	U.S.A.	New York	Carr Pond, Palisades Park
USNM 41353§	*Macrobdella* sp.	1	1 April 1950	U.S.A.	Louisiana	Chatham, Jackson Parish
USNM 41354§	*Macrobdella* sp.	1	1 April 1950	U.S.A.	Louisiana	Eureka, Ouachita Parish
USNM 42507	*Macrobdella decora*	1	29 July 1941	U.S.A.	Louisiana	Welch Lake
USNM 42558	*Macrobdella ditetra*	2	1923	U.S.A.	Louisiana	New Orleans
USNM 42615	*Macrobdella ditetra*	1	1951	U.S.A.	Florida	Gainesville
USNM 42667	*Macrobdella decora*	1	26 July 1935	Canada	Ontario	Joe Lake, Algonquin Park
USNM 42668	*Macrobdella decora*	11	7 August 1935	Canada	Ontario	Hilliard Lake, Algonquin Park
USNM 42694	*Macrobdella decora*	3	July 1920	U.S.A.	New York	Carr Pond, Palisades Park
USNM 43306	*Macrobdella decora*	1	–	U.S.A.	Rhode Island	Providence
USNM 43544§	*Macrobdella ditetra*	1	–	U.S.A.	Virginia	Near Great Falls of the Potomac
USNM 43562	*Macrobdella decora*	4	13 September 1911	U.S.A.	New York	North Rose
USNM 46292	*Macrobdella ditetra*	1	14 May 1969	U.S.A.	Mississippi	Grenada County
USNM 49410	*Macrobdella decora*	1	28 June 1968	U.S.A.	Illinois	Kyte River, Ogle County
USNM 50152	*Macrobdella decora*	1	20 August 1927	U.S.A.	New Jersey	Ramapo River, Mahwah
USNM 50153	*Macrobdella decora*	1	24 June 1930	U.S.A.	Texas	Near Austin
USNM 50154	*Macrobdella decora*	4	27 July 1930	U.S.A.	Michigan	Blue Lake, Kalkaska County
USNM 50155	*Macrobdella decora*	3	24 August 1930	Canada	Ontario	Anderson Lake
USNM 50156	*Macrobdella decora*	3	15 October 1934	U.S.A.	Michigan	Putnam Township, Livingston County
USNM 50157	*Macrobdella decora*	1	10 August 1936	U.S.A.	New York	Moodna Creek, Hudson drainage, Orange County
USNM 50158	*Macrobdella decora*	2	3 July 1937	U.S.A.	Michigan	Mitchell Lake, Wexford County

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Table 1.—Continued.

Catalog number	Scientific name	Specimen count	Collection date	Country of origin	State/province of origin	Precise locality
USNM 50159	*Macrobdella decora*	2	8 July 1937	U.S.A.	Maine	Great Brook, York County
USNM 50160	*Macrobdella decora*	2	23 July 1937	U.S.A.	Michigan	Craig Lake, Baraga County
USNM 50161	*Macrobdella decora*	1	6 August 1937	U.S.A.	Michigan	Kewaydin Lake, Marquette, Baraga County
USNM 50162§	*Macrobdella decora*	1	3 June 1938	U.S.A.	New Hampshire	Suncoop Pond, Rockingham County
USNM 50163	*Macrobdella decora*	1	29 June 1938	U.S.A.	Michigan	Lake of the Clouds, Ontonagon County
USNM 50164	*Macrobdella decora*	1	3 July 1938	U.S.A.	Kansas	White Woman Creek, Witchita County
USNM 50165	*Macrobdella decora*	4	12 July 1938	U.S.A.	Michigan	Gogebic County
USNM 50166	*Macrobdella decora*	1	16 July 1938	U.S.A.	Michigan	Sucker Lake, Gogebic County
USNM 50167	*Macrobdella decora*	1	30 August 1938	U.S.A.	Michigan	Wilson Lake, Marquette County
USNM 50168	*Macrobdella decora*	2	4 May 1939	U.S.A.	Michigan	Utica, Macomb County
USNM 50169	*Macrobdella decora*	1	31 July 1940	U.S.A.	Michigan	Chain of Lakes, Marquette County
USNM 50904	*Macrobdella decora*	2	26 June 1952	U.S.A.	Michigan	Dyer Lake, Dickinson County
USNM 51540	*Macrobdella ditetra*	1	5 November 1973	U.S.A.	North Carolina	Duplin
USNM 51562	*Macrobdella ditetra*	1	15 September 1972	U.S.A.	South Carolina	Francis Marion National Forest
USNM 51699	*Macrobdella ditetra*	4	–	U.S.A.	South Carolina	Georgetown
USNM 51738	*Macrobdella ditetra*	1	26 July 1959	U.S.A.	Georgia	McIntosh County
USNM 51739	*Macrobdella ditetra*	2	27 February 1970	U.S.A.	South Carolina	Fox Gully Branch, Francis Marion National Forest
USNM 51740	*Macrobdella ditetra*	1	14 March 1970	U.S.A.	South Carolina	Near Charleston
USNM 51741	*Macrobdella ditetra*	1	27 October 1970	U.S.A.	South Carolina	Turkey Creek, Francis Marion National Forest
USNM 51742	*Macrobdella ditetra*	3	7 March 1971	U.S.A.	South Carolina	Santee River
USNM 51762	*Macrobdella ditetra*	1	3 March 1972	U.S.A.	South Carolina	Bull's Island
USNM 51789*	*Macrobdella diplotertia*	1	–	U.S.A.	Missouri	Osage River, Osage County
USNM 51790^	*Macrobdella diplotertia*	6	–	U.S.A.	Missouri	Osage River, Osage County
USNM 53512	*Macrobdella decora*	2	7 May 1969	U.S.A.	Michigan	Fleming Creek, Washtenaw County

Table 1.—Continued.

Catalog number	Scientific name	Specimen count	Collection date	Country of origin	State/province of origin	Precise locality
USNM 56782	*Macrobdella ditetra*	2	25 April 1977	U.S.A.	Arkansas	Locust Bayou
USNM 1007614	*Macrobdella diplotertia*	1	30 April 2001	U.S.A.	Arkansas	Wildlife Management Area, Madison County
USNM 1007615	*Macrobdella diplotertia*	1	3 May 2001	U.S.A.	Arkansas	Wildlife Management Area, Madison County
USNM 1405211[§]	*Macrobdella sestertia*	3	3 June 1938	U.S.A.	New Hampshire	Rockingham County

possessed 2 + 1/2 annuli between the gonopores and 24 accessory gland pores on the ventral surface with the first row of pores seven annuli posterior to the female gonopore (Figs. 1, 2). The accessory gland pores occur in pairs on top of swollen tubercles in two groupings of two rows of three tubercles in each row (Fig. 3). These characters are diagnostic of *M. sestertia*. The three specimens of *M. sestertia* were removed from USNM 50162 and now comprise USNM 1045211.

Conclusions

This is the first report of *M. sestertia* from New Hampshire and represents the sixth time this poorly known species has ever been reported. The redetermination of the specimens of *M. decora* and *M. ditetra* are consistent with the geographic distributions of these common species.

Smith's (1977) suggestion that *M. sestertia* is distributed in Coastal Till Plains of New England is consistent with the previously known localities of this species (Fig. 4). The new locality in New Hampshire falls within the Northeastern Coastal Zone (map region 8.1.7) as defined by the Commission for Environmental Conservation (Wiken et al. 2011) along with the localities in Massachusetts. This region is characterized by warm summers and severe winters and is considered predominantly Dry Appalachian Oak forest (formerly Dry Appalachian Oak-Hickory forest) and Northeast Oak-Pine forests (Wiken et al. 2011). Sebec Lake, Maine is within the Maine/New Brunswick Plains and Hills (map region 8.1.8) with a climate that resembles the Northeastern Coastal Zone but predominantly Mixedwood forests. Smith and Hanlon (1977) reported finding, but not collecting, a sub-adult of *M. sestertia* from Harwich, Massachusetts, which falls within the Atlantic Coastal Pine Barrens (map region 8.5.4), a region with hot summers and cold winters and

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Fig. 1. USNM 1405211 *Macrobdella sestertia*. Top row: dorsal view. Bottom row: ventral view. Scale bar = 5 mm.

predominantly Oak-Pine forests (Wiken et al. 2011). These 3 ecoregions have similar climate of warm to hot summers and cold, sometimes severe winters, 110–230 frost free days per yr, mean annual temperatures between 4–11°C, mean annual precipitation between 890–1270 ml, and elevation below 500 masl, with abundant perennial streams, and deciduous forests with Oak (*Quercus*) and Pine (*Pinus*)

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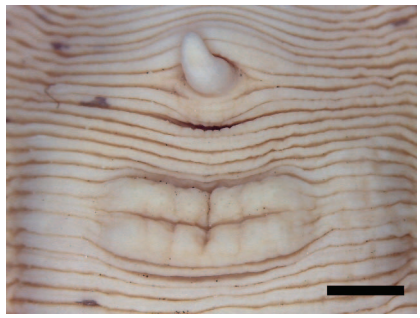


Fig. 2. USNM 1405211 *Macrobdella sestertia*. Ventral side with 2 + 1/2 annuli between the gonopores and 24 copulatory glands, diagnostic features of the species. Scale bar = 2 mm.

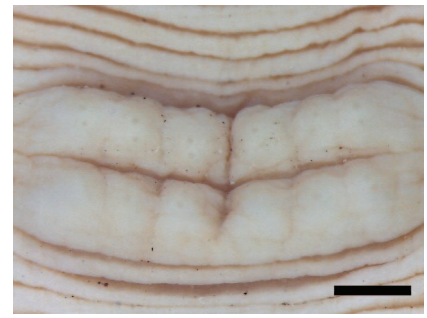


Fig. 3. USNM 1405211 *Macrobdella sestertia*. Copulatory glands with pores that occur in pairs on top of swollen tubercles in two groupings of two rows of three glands in each row. Scale bar = 1 mm.

species. *Macrobdella sestertia* likely has a patchy distribution throughout the coastal areas of New England predominantly within the Northeastern Coastal Zone but also within the Maine/New Brunswick Plains and Hills and the Atlantic Coastal Pine Barrens of New England (Fig. 4). This species likely prefers specialized microhabitats that are distributed within these map regions that may have changed with land use during the past 100 years.

In the time since Whitman collected the specimens of *M. sestertia* in the late 1800s, New England has experienced a period of forest recovery as farmers abandoned farmland and forest has returned, although since 2005 forest coverage has decreased and been replaced by new residential and commercial development in suburban areas (Jeon et al. 2014). The highest rate of forest loss has been in southern New Hampshire and eastern Massachusetts, a region central to the known geographic distribution of *M. sestertia*. Habitat degradation that alters these microhabitats within lakes and ponds of this region through changes in land use poses an imminent threat to this rarely encountered species (Massachusetts 2015 State Wildlife Action Plan).

An anecdotal report of 9 individuals of *M. sestertia* collected in 2008 from Edgefield County, South Carolina (Kohlsaat et al. 2005; Poly 2005) has not been verified and there is no mention of these specimens being deposited in a scientific collection. If corroborated, this would represent a significant range expansion for *M. sestertia*.

This is the first report of *M. decora* and *M. sestertia* being collected during the same collecting event. Sawyer (1972) and Smith (1977) suggested that the western extent of the geographic distribution of *M. sestertia* overlaps with that of *M. decora*. This new locality in New Hampshire indicates that the distribution of *M. decora* extends eastward, overlapping with *M. sestertia* and that these 2 species do occur in sympatry.

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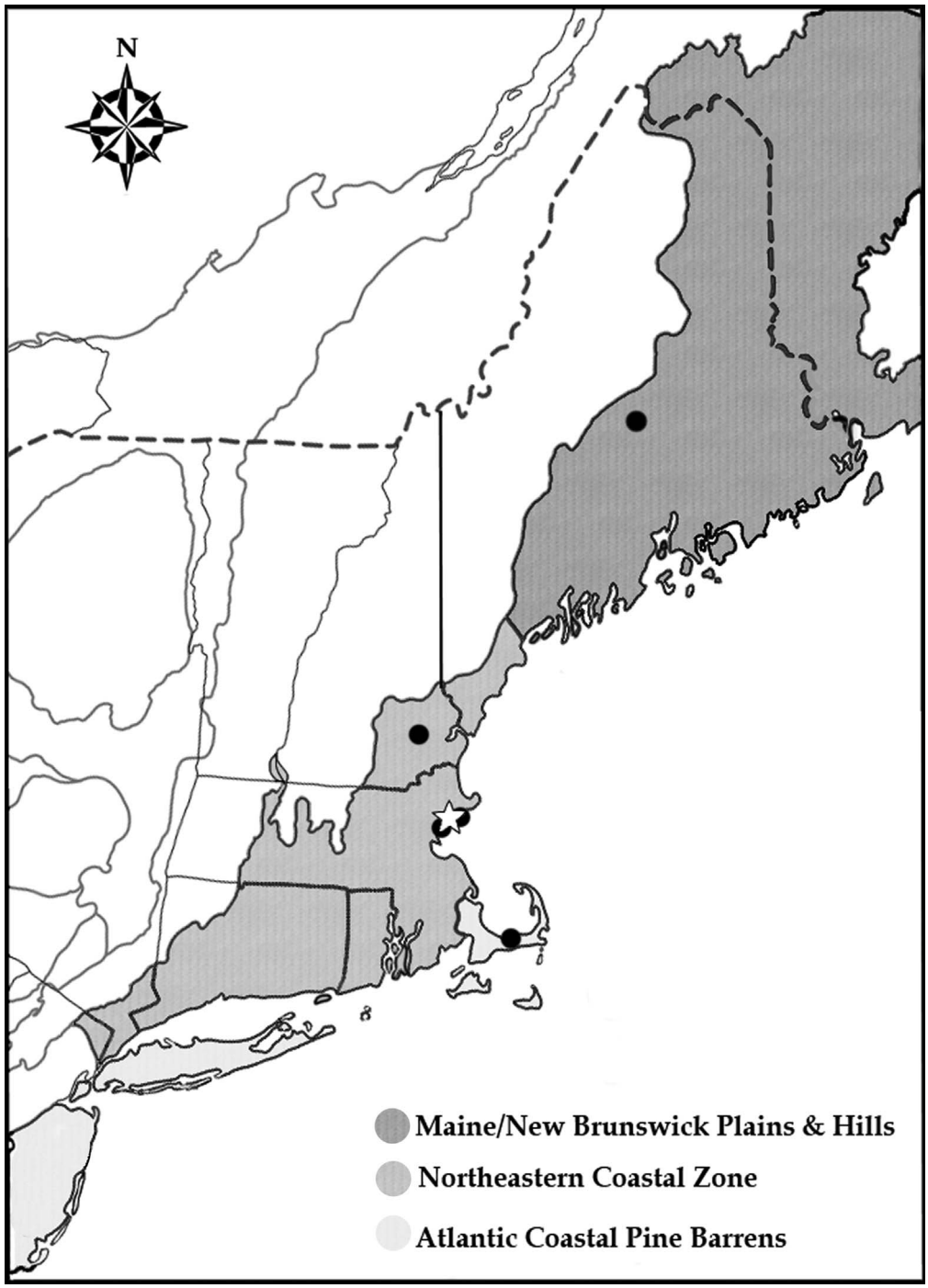


Fig. 4. CEC ecoregions (level III) of New England with the type locality (star) and distribution records (dots) of *Macrobdella sestertia*. Modified from Wiken et al. (2011).

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